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On the Distribution of *Tresus nuttalli* and *Tresus capax* (Pelecypoda: Mactridae) in the Waters of Puget Sound and the San Juan Archipelago

BY

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(Plate 27; 1 Text figure)

INTRODUCTION

Tresus capax (GOULD, 1850) (=*Schizothaerus capax*) and *Tresus nuttalli* (CONRAD, 1837) (=*Schizothaerus nuttalli*) are both widely distributed on sheltered intertidal flats along the West Coast of North America. They are frequently sympatric in their distribution, although in Puget Sound and adjoining coastal areas *T. capax* appears to be the dominant form. Though both species are frequently used as food and game in the coastal states of California, Oregon, and Washington there is a paucity of literature concerning them.

During the period from June 1960 to June 1962 the author had the opportunity to investigate the symbiotic relationships between the pinnotherid crabs, *Pinnixa faba* (DANA, 1851) and *P. littoralis* HOLMES, 1894, and their definitive host, the horse clam, *Tresus capax*. At the same time many observations were made on the distribution and biology of the host bivalve as well as the related *T. nuttalli*. This information is reported in the present paper.

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COLLECTING SITES AND METHODS

Two primary collecting sites were visited. One of these, Quartermaster Harbor, is a long, narrow embayment in southern Vashon Island, Washington (47° 22′ 30″ N; 122° 27′ 00″ W). The water of Quartermaster Harbor is received principally from southern Puget Sound. The second site was Garrison Bay at the western end of San Juan Island, Washington (48° 35′00″ N; 123° 09′05″ W). This island is part of the San Juan Archipelago and

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its shores are surrounded by waters derived from the Straits of Juan de Fuca and the Georgia Straits.

A grid system was established between the extreme high tide level and -2.2 ft tide level at both sites. Clams were removed in a systematic manner from 25 m^2 quadrats formed by the grid. All levels of the intertidal zone were thus uniformly sampled. Both sites were usually visited monthly and 10 to 25 bivalves were dug at each visit. The number collected on each date was determined by prevailing tidal and weather conditions. The species, length, dorso-ventral shell depth, and percent infestation by the pinnixids were determined for each *Tresus*. In addition the depth of substrate from which they were collected, was noted, and the air, surface, and burrow temperatures were recorded. Depths were noted as the distance from the surface of the substrate to the uppermost margin of the shell. Surface temperatures were read with the bulb of the thermometer shaded and resting directly on the surface of the substrate.

OBSERVATIONS

Differences were noted in the distribution of the two species at the two primary collecting sites. Whereas both *Tresus capax* and *T. nuttalli* were found at the Quartermaster Harbor site, although in different relative abundance, *T. nuttalli* was not found at Garrison Bay. This was true throughout a year of collecting (4 May 1961 to 18 June 1962). Of 204 *Tresus* dug at Quartermaster Harbor, 194 were *T. capax* and 10 were *T. nuttalli*. All 252 *Tresus* collected at Garrison Bay were *T. capax* (see Table 1).

Whereas the distribution of the two species was sympatric at one site, *Tresus nuttalli* appeared to be excluded from the second area. As *T. nuttalli* has been reported from other intertidal flats in the San Juan Archipelago (Swan & Finucane, 1952) it is probable that there were local foci of reproducing adults from which veliger larvae might spread. The author collected *T. nuttalli* in June 1961 from False Bay, San Juan Island, a relatively short distance from the Garrison Bay study area.

The differences in the distribution of the two clams may be due to more specific characteristics of the two environments. The site at Quartermaster Harbor was located on a gently sloping (9°) beach. During the lowest low water of a - 2.2 ft tide, approximately 63 m of beach was exposed between the low tide line and the extreme

Table 1

Occurrence of *Tresus capax* and *Tresus nuttalli* in collections made at Quartermaster Harbor and Garrison Bay, Washington; 4 May 1961 to 18 June 1962.

Quartermaster Harbor				Garrison Bay			
date	total *Tresus*	*Tresus capax*	*Tresus nuttalli*	date	total *Tresus*	*Tresus capax*	*Tresus nuttalli*
4 V 1961	13	13	0				
1 VI	9	9	0	14 VI 1961	24	24	0
12 VI	16	16	0	26 VI	13	13	0
28 VI	16	12	4	30 VI	7	7	0
26 VII	11	11	0	11 VII	18	18	0
				29 VII	15	15	0
				8 VIII	22	22	0
				22 VIII	32	32	0
22 IX	13	13	0	20 IX	22	22	0
24 X	14	13	1	25 X	10	10	0
21 XI	10	10	0	22 XI	20	20	0
20 XII	11	9	2	21 XII	21	21	0
17 I 1962	12	12	0				
3 II	18	18	0	2 II 1962	14	14	0
2 III	12	12	0	3 III	14	14	0
7 IV	14	13	1	8 IV	20	20	0
5 V	13	13	0				
26 V	8	6	2				
18 VI	14	14	0				
Totals:	204	194	10		252	252	0

Table 2

Variations in the "on site" substrate surface and siphon tube temperatures at Quartermaster Harbor; 150 feet below extreme high tide level.

date	substrate surface (shaded); °C	siphon tube, 6 cm below surface; °C
12 VI 1961	23.0	17.5
13 VII	26.5	20.0
26 VIII	24.0	18.0
3 II 1962	8.0	8.0
2 III	5.0	5.0

high tide level. The surface of the substrate consisted of a 7 to 10 cm layer of clean, fine sand. Below this the sediment was composed of a highly reducing glacial till containing large quantities of broken shell and organic debris. This layer was up to 75 cm thick. There was a distinct interface between these two strata. Whereas the sandy surface was relatively compact, the deeper materials were loose, porous, and easily dug.

The Garrison Bay site was quite different, however. The angle of slope was greater, 14.5°, and only 39 m of beach was exposed during a low tide of - 2.2 ft. The surface sediment consisted of a silty mud ranging from 5 to 8 cm thick and overlaid a hard, compact clay. The latter was quite dry and when a clam was removed from its burrow in the clay there was very little moisture on either the surrounding substrate or the valves of the clam.

Tresus were found at different depths within the sediment at the two sites. At Quartermaster Harbor individuals were taken between 9 and 45 cm below the surface, with a mean depth of 23.5 cm. At Garrison Bay, however, *Tresus* occurred from the surface to 27 cm with a mean of 14 cm.

The clams at Quartermaster Harbor were thus apparently able to burrow to a considerably greater depth than those found at Garrison Bay. The underlying hardpan found at the latter site was probably an impediment to deeper movement.

If, as was suggested by Swan & Finucane (1952), *Tresus nuttalli* is subject to killing freezes then its distribution might be predicted. Those juveniles developing in a substrate which permits relatively deep burrowing would survive, whereas individuals growing at or near the surface would perish as a consequence of intolerable changes in surface temperature. That an overlying substrate does provide effective insulation against higher temperatures in an intertidal environment can be judged from Table 2. On two occasions during the winter of 1961-1962 it was observed that the upper one or two centimeters of substrate at the Garrison Bay site were freezing whereas the lower strata were loose and unfrozen.

Tresus nuttalli collected at Quartermaster Harbor were found at or below the 150 ft line from extreme high tide level; *T. capax* were distributed up to the 60 ft level. The length of time that the *T. nuttalli* were uncovered during any one tidal period was thus less than that for *T. capax* found higher in the intertidal zone. The former species would appear to avoid undue or prolonged exposure to widely varying seasonal temperatures.

Kanwisher (1955), in a study on freezing in intertidal animals, states that: "No animal was found to stand low temperatures and large internal ice formation that is not faced with these conditions in nature." As *Tresus nuttalli* in Puget Sound is at or near the northern limit of its range it is quite probable that temperature correlated with sediment-depth is a controlling factor in its distribution in that area.

The size attained by *Tresus capax* at the Garrison Bay site was greater than at Quartermaster Harbor (Figure 1). While at Quartermaster Harbor the clams did not exceed 160 mm in length, at Garrison Bay 27 percent of the total specimens collected fell within the 161 - 200 mm length group. Swan (1952) presents experimental evidence that substrate texture and composition may affect the linear growth rate, shell weight, and linear dimensions of the bivalve *Mya arenaria*. More recently Addicott (1963) reported that a fossil *Tresus nuttalli* found in a restricted position in a Pleistocene sandstone had grown abnormally. It would appear that sediment conditions can affect linear shell growth and maximum size and the differences in growth of *T. capax* can probably be attributed to the sediment composition at the two sites.

The position of the two clams in the two substrate types is also of interest. Whereas both *Tresus capax* and *T. nuttalli* at Quartermaster Harbor were oriented with their antero-posterior axis at an angle approximately 45° to the vertical, as depicted for *T. nuttalli* by Pohlo (1964: 322), at Garrison Bay *T. capax* were frequently found with this

Explanation of Plate 27

Figure 1: Visceral mass of *Tresus capax*. Left mantle tissue reflected to reveal visceral skirt which overlies tip of ruler. Compare with Figure 2.

Figure 2: Visceral mass of *Tresus nuttalli*. Note the lack of a visceral skirt.

Figure 1

Figure 2